EFFECT OF PESTICIDES AND NUMBER OF SEED PER SPOT ON SEEDLING ESTABLISHMENT FROM DIRECT-SOWN OCALA SAND PINE SEED [1]

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Abstract. To improve spacing and conserve seed, the U.S. Forest Service began using the Bracke™ scarifier for regenerating Ocala sand pine [Pinus clausa var. clausa (D.B. Ward)] stands about 6 years ago. The objectives of this study were to (1) determine if seed treatment with pesticides was necessary to control seed predation, and (2) determine the number of seed to sow on each spot to obtain the desired level of stocking. Although some seed predation did occur, seed treatment with Arasan™ or Ropel™ did not significantly increase seedling establishment. And while the shading of seed spots did increase seedling establishment, it is likely not economically feasible. Increasing the number of seed from two to five per spot increased stocking by nearly three times: 23 vs. 63 percent. Doubling the number of seed to 10 gave no additional increase in stocking levels. Thus, if sown during the proper season, seed predation is not severe enough to justify the use of repellants, and five well-placed seed per spot is adequate for obtaining a well-stocked stand of Ocala sand pine.

Introduction

In the past most Ocala sand pine (Pinus clausa var. clausa D.B. Ward) stands harvested on the Ocala National Forest, Florida, were regenerated by chopping or chopping and burning, followed by broadcast seeding using 0.55-1.1 kg/ha of seed (Price 1973). Although this system was good, it was not entirely satisfactory. Many areas during years with extended drought periods, which occur about 3 years out of 10, failed to regenerate adequately. In good years with adequate rainfall, some areas became overstocked and required precommercial thinning to prevent stand stagnation. Additionally, there was no spacing control and the system was quite wasteful of seed, which increased the cost and reduced the area that could be regenerated with genetically-improved seed. To improve spacing, eliminate precommercial thinning, reduce costs, and conserve seed, managers on the Ocala National Forest began using the Bracke™ scarifier-seeder in the mid-1980s. This is an integrated method which combines site preparation and seeding into one operation. It was very successful the first year, but in subsequent seasons a significant number of areas failed to achieve adequate stocking.

It was suspected that seed predation was at least partially responsible for these failures because past work had shown it could and often is a substantial problem in artificial regeneration of Ocala sand pine stands by direct seeding.

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only 3 percent of unprotected, viable seed sown on test sites by Cooper et al. (1959) produced seedlings, while the rate was nearly 90 percent from protected seed. Similar results occurred when Ocala sand pine seed were sown on sandhill sites in northwest Florida (Burns and McReynolds 1975). In the past, severe seed predation was overcome by the use of various pesticides, but many effective formulations are no longer available, or because of environmental concerns land managers do not choose to use them. The objective of the first portion of this study was to determine if pesticides presently available for treating seed would be effective in reducing predation of Ocala sand pine seed on sites regenerated with the Bracke scarifier-seeder.

Because it deposits seed only on selected microsites (Van Damme 1988), the scarifier-seeder mechanism uses less seed than the broadcast system. The initial seeding rate was 0.3 kg/ha which was increased to 0.35 kg during the third sowing season. The actual amount of seed required for successful regeneration, however, was unknown. The objective of the second phase of this study was to determine the number of seed required per spot, or scalp, to give an adequate stocking without wasting valuable seed.

Methods

All study sites were on the Lake George district of the Ocala National Forest located in central Florida. Specific sites were chosen at random from sand pine sites regenerated with the scarifier-seeder equipment during the 1986 season, spanning November 1986 to February 1987. These mechanisms are equipped with rotating teeth, which turn over a spot of soil to create a pit-and-mound microsite, typically 0.4-m wide x 1-m long with a 30-cm deep pit (Van Damme 1988). Both the two-row and three-row machines used were adjusted to create about 2,300 scarified spots/ha.

The pesticide portion of the study was installed on 2 February 1987 on three sites using three seed treatments and three levels of seed protection in a factorial design. The three seed treatments were control, Ropel™, and Arasan™. Seed protections were none, shade, and screen. All seed used in the study were from general forest cone collections and had a laboratory germination rate of 80 percent. The Ropel treatment was applied by soaking seed in the liquid for 1 min followed by air drying. Latex was mixed with Arasan at a rate of 40 ml/L. This mixture was applied to dry seed until thorough coating took place, then seed were spread on a concrete surface to dry. Shade was provided by a 30 x 30-cm square of aluminum mesh screen with 1-mm square openings. The screen cover used the same aluminum mesh formed into a 30 x 30 x 15-cm box.

On each of the three study sites, a row of nine scarified spots was selected at least 100 m from stand edge. In the center of each spot a sowing area was prepared by turning moist soil to the surface and lightly smoothing it to simulate a freshly-created Bracke spot. For screen spots, a hole about 5-cm deep was made for the box, the box was put into this hole, and soil was placed inside the box. Next, 100 holes were made on each of the 9 prepared spots by pressing 4-mm-diameter hollow tubes attached to a 30x30-cm board in a 10x10 configuration and protruding 1 cm into the bare mineral soil. Then, seed of the selected treatment were placed in these holes and soil was brushed over the top. After sowing, the shade treatment was installed about 25 cm above the appropriate spots by attaching the piece of screen to four wire pins. Tops of the screen boxes were wired in place to prevent entry by birds or rodents.

The second part of this study was installed on four areas on 3 February 1987. On each site, three adjacent rows of ten scarified spots were selected for use. Next, a row was assigned to receive 2, 5, or 10 seed per scarified spot. Spots were prepared for sowing as explained above. Then seed were placed in a line of holes 1-cm deep and 2-cm apart across the center of the prepared area. After marking the beginning and end of each line with wire pins, seed were covered with soil.

Study sites were checked periodically during the first 4 weeks when evidence of seed predation was recorded. Beginning about 5 weeks after sowing, the number of seedlings on a spot was counted and recorded. These field data were used to calculate seedling percentage, the number of seedlings as a percent of the total number of seed sown, for the pesticide portion of the study. Percent stocking, the number of spots with at least one live seedling, was used to evaluate the second portion of the study. Analyses of variance after arc sine transformation of percents and the Least Significant Difference methods were used to compare treatment means.

Results

In the first part of the study, 7 weeks after sowing neither pesticide significantly increased the seedling percentage over levels on plots sown with untreated control seed (Table 1). Spots with Arasan-treated seed, however, did have more seedlings than those sown with Ropel-treated seed. There were fewer seedlings on spots sown in the open compared with those with shade or complete screen cover. Seven months after sowing, there were no significant differences in seedling percentages due to pesticide treatment of seed. Seedling mortality had been higher on shaded than on screened spots, but both still had significantly more seedlings than the open spots.

Five weeks after sowing, in the second part of the study, spots with five seed had significantly greater stocking than those where only two seed were used (Table 2). Although the use of 10 seed also increased stocking in comparison with 2, it gave no additional increase over the 5-seed-per-spot rate. There was a small decrease in stocking at all rates over the next 5 months. At the end of the study, spots sown with five seed had about three times the level of stocking of those sown with two seed. Although there was considerable variation in stocking between study locations, even on the poorest site stocking was 30 percent for spots sown with five seed. Doubling of the number of seed, from 5 to 10, had no additional effect on percent stocking.

Discussion

Seedling establishment for the first portion of the study was equally good on both shaded and screened spots for all types of seed. Since the

Table 1. The effect of seed treatment and level of protection on seedling percent from direct sown Ocala sand pine seed.

Cover	Seed treatment: Untreated	Arason™	Ropel™	Mean
	------------- seedling percent -------------			
7 weeks after sowing				
Open	65	64	28	52 a[a]
Shaded	71	75	69	72 b
Screened	65	86	76	76 b
Mean	67 ab	75 b	58 a	
7 months after sowing				
Open	56	48	19	41 a
Shaded	67	51	64	60 b
Screened	64	83	78	75 b
Mean	62 a	61 a	54 a	

[a] Means within a row or a column for each time period not followed by the same letter are significantly different at the 0.05 level.

Table 2. Effect of the number of seed sown per spot on stocking.

Number of seed sown per spot on 2/3/87	Percent stocking on 3/10/87	Percent stocking on 8/25/87
2	30a[a]	23a
5	73b	63b
10	68b	60b

[a] Means within a column not followed by the same letter are significantly different at the 0.05 level.

seed on screened plots had complete protection from seed predators, this illustrates that seed predation was not a significant factor in this study. Thus, it is not surprising that neither of the pesticides used gave an increase in seedling establishment.

Lack of significant seed predation could be partially due to weather tions during the study. Average precipitation for February and March 3 and 12.7 cm, respectively. Precipitation during February following establishment was 19.3 cm, and 26.7 cm during March-- both consid- y above normal levels. Good rainfall promotes rapid germination which rn reduces exposure time of seed to predation. However, seed were exposed to predation for at least 4 weeks before germination began, eed predation did occur, as digging and empty seed coats were noted l study spots. The level of predation, however, was not high enough gnificantly affect seedling establishment. This is contrary to re- from past studies (Cooper et al., 1959; Burns and McReynolds 1975) seed predation was very severe. Both of these studies were on small with surrounding cover for seed predators, while in the present study lots were a considerable distance from surrounding stands. This indi- seed predation is not usually a severe enough problem to justify the f pesticides when regenerating large Ocala sand pine stands.

iading the seed after sowing, i.e., the shaded and screened spots, in- ed seedling establishment. This is likely due to lower water loss shaded spots which would increase seed germination. Although it l be beneficial, at present there is no way to economically provide for direct-sown seed.

ie minimum acceptable stocking level for Ocala sand pine is 30 per- The second portion of this study shows that the rate of two seeds racke spot is too low to produce acceptable stocking. Increasing the to five seeds, however, should provide enough seed to give adequate ng. Any increase beyond this will not increase stocking and would be ul of costly seed ($110/kg). Since not all seed sown by the Bracke ier-seeder are dropped in a suitable microsite, the question which s, "How many seeds to put out with the Bracke scarifier to obtain the d five well-placed seeds per spot?"

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